Doom and gloom versus optimism: An assessment of ocean-related U.S. science journalism (2001-2015)

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A B S T R A C T

In recent years, some scientists have expressed concern about the negative representation of the state of the oceans in the media. To examine this concern empirically, we analyzed the content of 169 articles in mainstream U.S. newspapers covering ocean-related research between 2001 and 2015. Content was categorized according to main issue, basis of evidence, causal attribution, presence of solutions and uncertainty, and coded for doom and gloom and optimistic language. Science journalism about ocean issues most commonly addressed climate change and the status of ocean species or populations. The majority of articles cited peer-reviewed research. Most articles attributed change to anthropogenic causes, although ocean science articles addressing climate change were less likely to do so. Uncertain language and solutions were observed in nearly half of all articles. Optimistic language outnumbered doom and gloom language across all categories. While doom and gloom language was identified in 10% of all articles, optimistic language was present in 27%.

1. Introduction

Reporting by the mass media can profoundly impact public perception of environmental issues (e.g., Ogden, 2015) and has been, for instance, a powerful actor in the public understanding of climate science (Stamm et al., 2000; Carvalho and Burgess, 2005; Cooper, 2011; Brulle et al., 2012; Schmidt et al., 2013), extinctions (Ladle et al., 2004), and genetically modified organisms (Mintz, 2016). However, while the mass media have the potential to effectively communicate environmental issues, various factors such as competition for shrinking news space (Friedman, 2004), the prioritization of event-driven coverage (Hansen, 2010), and the relative invisibility and long timeframes of many environmental phenomena present major challenges for journalists. Furthermore, factors such as the journalistic norms of objectivity, balance, dramatization, personification, and novelty can be problematic in science and environmental coverage (Boykoff and Boykoff, 2007). For example, a 2004 review of U.S. news articles demonstrated how the journalistic norm of balance - or the proclivity to tell 'both sides' of the story - leads to coverage that questions the causes of climate change and problematic disagreement between scientists and science reporting (Boykoff and Boykoff, 2004). These factors, among others, have led to the mass media's potential to misinterpret, misconstrue, or otherwise misinform the public (Henderson-Sellers, 1998; Boykoff, 2008). Therefore, it is important to examine media coverage and the representation of complex environmental issues.

As an example, scientists have debated the potential benefits and consequences of the mass media's extinction-risk coverage. Some scientists have argued that overly simplistic representations of research and a failure to clarify scientific uncertainty around the time frames of various land animal and plant species extinctions may lead to accusations of frivolously 'crying wolf' (Ladle et al., 2004). Other scientists have contended that mass media coverage of the extinction risks posed by climate change, despite the potential negative effects of errors in reporting, is ultimately beneficial as it has raised public awareness considerably (Hannah and Phillips, 2004).

In recent years scientists have expressed similar concerns over the representation of the state of the oceans in science journalism. Duarte et al. (2015, p. 131) wrote that "recent media reports on problems in the ocean do not leave much room for optimism." Referring to press coverage of an article about marine biodiversity by Worm et al. (2006), Hilborn (2010, p. 5) wrote, "if you have paid any attention to the conservation literature or science journalism over the last five years, you likely have gotten the impression that our oceans are so poorly managed that they soon will be empty of fish…". In a similar vein, the website http://oceanoptimism.org noted, "We recognise and respect the many challenges facing our oceans, yet too often 'doom and gloom' stories are the only kind of ocean news we hear."

The representation of the state of the oceans is important, since the

Table 1
Distribution of articles by topic, presentation of solutions and uncertainty, and causal attribution.

Category	Total % (n)	Solution present % (n)	Uncertainty present % (n)	Anthropogenic attribution % (n)
All	100% (169)	45% (76)	49% (82)	62% (105)
Climate Change	47% (80)	35% (28)	49% (39)	39% (31)
Species and/or Population status	39% (66)	62% (41)	38% (25)	71% (47)
Pollution	31% (52)	46% (24)	60% (31)	83% (43)
Offshore Drilling	14% (23)	13% (3)	78% (18)	96% (22)
Aquaculture	3% (5)	100% (5)	60% (3)	100% (5)

failure to accurately report ocean health issues, or a tendency to bias ocean coverage with hyperbolic doom and gloom rhetoric, is likely to send very different messages to the broader community. For example, Duarte et al. (2015, p. 131) expressed that the current framing of ocean health issues runs the risk of conveying "an overly negative message that may lead society into pessimism or the belief that the ocean is beyond restoration." Hilborn (2010, p. 5) expressed concern that popular media depictions of ocean issues distort reality and ignore a more balanced diagnosis of the world's fisheries, favoring instead a counterproductive, "apocalyptic rhetoric that obscures the true issues that fisheries face" and fails to recognize "the long, hard work of fishery managers, scientists and stakeholders in the many places where management *is* working" (p. 8, emphasis in original).

However, the evidence for claims of constant doom and gloom in media depictions of the ocean is lacking (Jacquet et al., 2015). Empirical support is superficial and no research has systematically examined the U.S. media's portrayal of the state of the oceans. In an effort to provide the groundwork of empirical evidence needed to further explore the debate over whether or not news media tend to emphasize doom and gloom and fear-inducing rhetoric over more balanced and/or optimistic appraisals, the goal of this work was to examine the ways that ocean-related issues have been represented in major U.S. news media outlets from 2001 to 2015, including how ocean-related issues rank on the news media agenda, as evidenced by their frequency of coverage. In addition, this research explored how ocean-related issues have been framed in U.S. news media, including how these narratives attribute causality, address uncertainty, provide evidence, and indicate solutions. Finally, adapting methods used in prior analyses of climate discourse, we examined the frequencies with which doom and gloom or alarmist rhetoric as well as ocean optimism were used in recent discussions of the state of the oceans.

2. Methods

This study reviewed 169 articles published in four major U.S. newspapers (The *New York Times*, the *Washington Post,* the *Los Angeles Times*, and the *Wall Street Journal*) between July 2001 and February 2015 that addressed the state of the oceans. These newspapers, for reasons of geography, influence, circulation, and impact have been used in several past analyses to represent US media and were therefore deemed appropriate for this study (Boykoff and Boykoff, 2004; Wilkins, 1993). This start date was chosen because in July 2001, Jackson et al. (2001) published one of the most highly cited papers in marine ecology (cited 3178 times as of December 2017 according to the Web of Science), which articulated a large-scale view of anthropogenic ocean-related changes and generated substantial media coverage.

The sample was compiled using the search terms 'ocean' and 'science' in the ProQuest Newsstand database. With the purpose of exploring how marine science is presented in news media, opinion editorials, letters to the editor, book reviews, and editorial columns were excluded, similar to other media content analyses of environmental issues (e.g., Hedman, 1981; Boykoff and Boykoff, 2004). The subject area of 'studies' was also selected as a search parameter to confine the sample to journalism about scientific studies, as this ProQuest Newsstand category generally implies that the article is about, or makes

mention of, scientific research. Within these selection parameters, 403 news articles appeared from 2001 to 2015. A preliminary reading reduced the sample size to 276 after duplicates and articles that did not address ocean science were removed. In addition, articles were screened to confirm that they related to at least one contemporary ocean-related issue and those that did not were excluded from the sample. For example, an article might have focused on a novel approach to studying air pollution or ocean toxins without directly addressing pollution (#108 in Table S2), or described research on a mass marine extinction that occurred 360 million years ago without addressing current species or population status (#127 in Table S2). This screening process produced a final sample of 169 articles. Of these articles, 34% appeared in the *Los Angeles Times* (58 articles), 32% in the *Washington Post* (53 articles), 26% in the *New York Times* (44 articles), and 8% in the *Wall Street Journal* (14 articles) (Table S1).

After a preliminary reading of all articles, five primary issue categories were identified: 1) climate change; 2) pollution; 3) species/population status; 4) offshore drilling; and 5) aquaculture (see Table 1 for percentage and number of total). Articles were assigned to a category if that issue was the dominant focus of the article. Similar to other media analyses (e.g. Feber et al., 2017), several articles covered more than one dominant issue and were counted as one hit for each of the relevant categories, therefore percentages do not sum to 100. For example, an article might have focused on the negative impact of industrial fishing on species abundance and sustainability but also discussed climate change and the projected poleward shift in the ranges of exploited fisheries, and was therefore classified under both species/population status and climate change. Most articles addressed one (120 articles, 71%) or two (38 articles, 22%) of the five dominant categories. The remaining 11 articles (7%) addressed 3 categories.

Articles were classified according to causal attribution (whether or not impacts were attributed to anthropogenic factors), whether they proposed a potential solution, including an intervention, policy, or management strategy perceived as potentially limiting or reversing the scope of the problem, as well as the type of evidence cited (peer-reviewed research, governmental or other scientific reports or documents, or no evidence provided). Articles were also classified according to whether they included language that referred to uncertainty regarding the issue, for example, if the results of the study were called into question, or content was politicized, including when uncertainties about aspects of the science were used to cast doubt on the science overall (Oreskes and Conway, 2010; Steketee, 2010; Bolsen and Druckman, 2015).

Finally, articles were examined for doom and gloom as well as optimistic content. This examination used methods similar to Risbey's (2008) and Russil and Nyssa's (2009) work on representations and tropes used in climate change communication. As is often the case in qualitative content analyses, the terms used in the coding process may have a range of meaning to different audiences, and therefore some necessary degree of subjectivity is involved. Ereaut and Segnit's (2006) characterization of alarmism was used to establish the presence of doom and gloom language with support from Hulme's (2006) critique of catastrophe discourse, and Risbey's (2008) clarification of terms. The authors characterized alarmism as using inflated or extreme language, the use of a quasi-religious or apocalyptic language around doom,

Table 2
Distribution of doom and gloom and optimistic language by article category.

Category	Total % (n)	Doom and Gloom % (n)	Example (source*)	Optimism % (n)	Example (source*)
All	100% (169)	10% (17)		27% (46)	
Climate Change	47% (80)	14% (11)	"Within my generation, whatever climate we were used to will be a thing of the past" (#132).	21% (17)	"Nature is very adaptable [...] it always changes to something else. It never changes to nothing" (#126).
Species and/or population status	39% (66)	15% (10)	"At this point, without human intervention, the species could go extinct within our lifetimes" (#116).	35% (23)	"But there is still time to avert catastrophe…the oceans are mostly intact, still wild enough to bounce back to ecological health" (#164).
Pollution	31% (52)	8% (4)	"this century is the last century of wild seafood unless there are fundamental changes in managing ocean ecosystems" (#42).	35% (18)	"…despite widespread public perceptions that coastal waters are becoming increasingly degraded, water quality off Huntington Beach has actually improved over four decades" (#11).
Offshore Drilling	14% (23)	4% (1)	"The oil is not gone and is not going away anytime soon" (#88).	39% (9)	"The Gulf of Mexico ecosystem was ready and waiting for something like the Deepwater Horizon blowout and seems to have made the most of it…" (#91).
Aquaculture	3% (5)	20% (1)	"The wild population is dropping so fast that there isn't much time left to act" (#51).	40% (2)	"The problem looks severe, and it is definitely serious, but the good news is that there is a remedy that is proven to be economically effective" (#50).

*See Supplementary material.

death, or lack of renewal, and such words as 'catastrophe,' chaos,' 'hopeless,' 'overwhelmed,' 'helpless,' 'calamity,' and 'disaster,' In addition, doom and gloom rhetoric tends to signify the immensity, irreversibility, rapidity, and urgency of an environmental issue, often by emphasizing a narrative where present conditions are described as worse than previously thought and outcomes are projected to coalesce in a final catastrophic end-point beyond the purview of human agency (Brummett, 1991; Foust and Murphy, 2009). Furthermore, this type of language may utilize metaphors and omens, or predictions of war and violence, and often extends the scale of the physical threat to encompass global society (Ereaut and Segnit, 2006). The 'doom and gloom' perspective examined here, therefore, is particularly concerned with an examination of qualifiers and other language that construct the future as catastrophic, unavoidable, and characterized by global risk, danger, and threat. For optimistic content, past research has defined optimism not simply as the absence of pessimism, but rather as existing when there is the presence of language infused with agency, revealing positive progress and expectations about the future, the belief that goals can be achieved and harm is reversible, along with a sense of manageability, resilience, hope, and possibility (Seligman, 1991; Scheier and Carver, 1992; Snyder, 1994).

Inter-coder reliability was assessed over three time periods. First, both authors read and classified the first 10 articles in the sample. Discrepancies were resolved through discussion. Then both authors classified the next 10 articles, which produced 95% agreement. The first author then read and classified the remaining articles, with the second author conducting a check of 10 random articles to confirm classifications, which again resulted in 95% agreement.

3. Results

The 169 articles (Table S1) included 80 on climate change (47%); 66 on the status of a species or population (39%); 52 on pollution (31%); 23 on offshore drilling (14%); and 5 on aquaculture (3%) (Table 1). The vast majority of articles cited peer-reviewed research (64%, 108 articles) or another form of governmental or scientific report (30%, 51 articles), with 6% of the total (10 articles) not explicitly mentioning a source or study. Solutions were identified in 45% of all articles (76 out of 169) and ranges varied broadly by issue. All articles on aquaculture (5 in total), 62% of articles on species/population status (41 articles), and 46% of articles on oceanic pollution (24 articles) mentioned potential remedies or solutions with articles on oceanic climate change and offshore drilling less likely to include potential solutions (Table 1).

Uncertain language was identified in 49% of all articles (82 out of 169), with frequencies varying by category. Seventy-eight percent of articles on offshore drilling (18 in total), 60% on oceanic pollution (31 articles), 60% on aquaculture (3 in total), and nearly half of all articles on oceanic climate change (49%, 39 articles) presented uncertainty or politicized information. Articles on species or population status were the least likely to present uncertainty (38%, 25 articles) (Table 1). Furthermore, most articles attributed anthropogenic factors as the primary cause (62%; 105 articles). When broken down by issue, climate change was the only category in which the majority of articles did not attribute causes to human behavior (39%; 31 articles) (Table 1). The remaining articles on climate change either did not mention attribution (27%; 22 articles), stated or implied that causes are unknown (15%; 12 articles), or mentioned that climate change is a result of a combination of anthropogenic and natural factors (14%; 11 articles) or natural factors alone (5%; 4 articles).

3.1. Doom and gloom v. optimism

Overall, doom and gloom language was present in ten percent (17 articles) of all articles in this study. However, only 7 articles (4%) contained only this type of language, while the remaining articles

expressed doom and gloom as well as optimistic language. Alarmist rhetoric was identified in 1 out of 5 articles on aquaculture (20%), 10 out of 66 articles on species or population status (15%), 11 out of 80 articles on climate change (14%), 4 out of 52 articles on pollution (8%), and 1 out of 23 articles on offshore drilling (4%) (Table 2). An analysis of headlines, however, showed that headlines used more alarmist terminology (e.g. "ravaged," "collapse," "doom," "smoking gun," "decimated," "perils," "menace," "lethal," "crisis," "catastrophe," "disaster," "dire," "point of no return," "unstoppable," etc.) compared to the articles (21% or 35 headlines v. 10% or 17 articles).

Optimistic language was found to be more prevalent in coverage of the state of the oceans than doom and gloom language (46 articles, or 27% of the total), and 21% (36 articles) contained only optimistic language and no doom and gloom. Forty percent of articles on aquaculture (2 out of 5), 39% on offshore drilling (9 out of 23), 35% on pollution (18 out of 52) and 35% on species or population status (23 out of 66) contained optimistic language. Articles on climate change were least likely to contain optimistic language (21%, or 17 articles). Somewhat surprisingly, while 6% (10 articles) contained both optimistic and doom and gloom language, the majority of articles reviewed (116 in total, 69%) did not contain either category, indicating an overall tendency to avoid either type of framing in ocean science reporting.

The use of doom and gloom language differed by issue category (Table 2), but not significantly by outlet (see Supplementary material, Table S3). Alarmist rhetoric identified in articles pertaining to species or population status most frequently conveyed a sense of hopelessness ("[…] *in most places, fisheries managers are arriving too late*" (#16 in Supplementary material, Table S1)), stressed urgency (*"at this point, without human intervention, the species could go extinct within our lifetimes"* (#116)), and extended the threat to encompass global society (*"if current practices continue […] the world can expect serious economic disruptions, food shortages in seafood-dependent developing nations and lasting damage to marine ecosystems*" (#17)). Optimistic language, which was more prevalent across every article category, highlighted manageability (*"the data show there's a solution to this problem that can be applied broadly"* (#121), progress ("*there has been some good news […] things are moving in the right direction*" (#20)), and reasons to remain hopeful ("*yet there is hope […] available data suggest that at this point, these trends are reversible*" (#42), *"on a bright note […] there have been very few documented cases of outright extinction of marine species"* (#1), and *"as long as you don't take too many, those populations can rebuild and rebuild fairly effectively*" (#158)). In other words, there are "*glimmers of hope*" (#17). Overall, optimistic language about species status conveyed that "*the oceans are mostly intact, still wild enough to bounce back to ecological health"* (#164), however, we must *"find the conviction to do it"* (#25).

Doom and gloom language related to climate change tended to include quasi-religious references to doom, decay, or death, as well as highlight the immensity and intractability of the problem. For example, an article discussing the effects of warming temperatures on heat-stressed corals began, "*A ghostly pallor is overtaking the world's coral reefs…* "(#102), and another article, discussing the effects of warming water temperatures on Long Island Sound's declining lobster population, stated that the implications were "*ominous*" (#12). Most common in doom and gloom related U.S. media coverage of climate change, however, is language referring to its seemingly indomitable momentum and intractability, for instance, that "*there is no red button to stop this*" (#145), or that it is a "*chain reaction that's unstoppable*" (#149). On the other hand, optimistic language identified in articles on climate change often addressed the socio-ecological system's resilience (*"there is no need for undue alarm […] societies have demonstrated they are good at adapting to serious climate change"* (#4), and mutability ("*Nature is very adaptable […] it always changes to something else. It never changes to nothing*" (#126)). In addition, optimistic language was tied to conservation efforts (*"reef advocates say significant progress has been made in conservation efforts over the past two decades* […] *if we keep local threats low, coral reefs

will be able to get over the climate hump"* (#102), and *"The optimistic way to look at this is that taking steps to reduce emissions is buying us time – for species to adapt, for human societies to change and to come up with technological advancements"* (#132)).

Media about pollution included doom and gloom rhetoric most often by stressing the urgency and an immediate need for action. For example, one article indicated that "*this century is the last century of wild seafood unless there are fundamental changes in managing ocean ecosystems*" (#42), and another mentioned "*there isn't much time left to act*" (#51). Optimistic language found in articles on pollution tended to focus on nature's resilience. For example (referring to recovery after the Deepwater Horizon oil spill) coverage noted "*some species may, however, have done better than it seemed at first*" (#101), and "*the Gulf of Mexico ecosystem was ready and waiting for something like the Deepwater Horizon blowout and seems to have made the most of it*" (#91). In another context, optimistic language highlighted human agency through the implementation of successful policy (*"although the flame retardants had been doubling every four to five years in Arctic ringed seals from 1981 to 2000, they have stabilized as the bans on the two compounds go into effect"* (#33), as well as "*despite widespread public perceptions that coastal waters are becoming increasingly degraded, water quality off Huntington Beach has actually improved over four decades. Much of that improvement is tied to the 1972 Clean Water Act and projects that help keep sewage and urban runoff from hitting the water*" (#11)).

Seventy-four percent (17 out of 23 articles) on offshore drilling focused on the *Deepwater Horizon* oil spill event, which began on April 20, 2010, with nearly half optimistically commenting on the rapid dispersion and breakdown of oil. These articles relayed that "*the image of this spill being a complete disaster is not true*" (#83) with "*nature's microbial helpers […] doing a better job than researchers had expected*" (#90).

Optimism associated with aquaculture highlighted agency and knowledge of workable solutions. For example, in reference to moving fish farms to enclosed, land-based facilities, one conservationist said "*the problem looks severe, and it is definitely serious, but the good news is that there is a remedy that is proven to be economically effective*" (#50).

3.2. Solutions

Forty-five percent of all articles (76 out of 169) mentioned potential solutions. Articles that contained only optimistic language, as well as articles that contained both optimistic and doom and gloom language were likely to include solutions (67% [24 articles] and 70% [7 articles], respectively.) Articles that included only doom and gloom language, or those that did not include either category were less likely to mention solutions (43% [3 articles] and 36% [42 articles], respectively). All articles on aquaculture (5 total), 62% of articles on species or population status (41 articles), 46% of articles on pollution (24 articles), 35% on climate change (28 articles), and 13% on offshore drilling (3 articles) proposed a potential solution, including an intervention, policy, or management strategy (Table 1).

Articles addressing climate change were among the least likely to mention potential solutions or courses of action. Of the 28 articles that included solutions, a call for the reduction of greenhouse gas (GHG) emissions was most common, mentioned in all but four. Adaptive measures related to sea-level rise, such as building up seawalls and wetlands, replenishing shorelines, raising ground elevation, constructing new levees, and moving structures inland, were also mentioned.

Articles addressing pollution covered a wide range of topics, from non-point runoff, to plastics, sound, sewage, and radioactive contaminants. The most frequently proposed solutions included the reduction or phasing out of damaging toxins and chemicals, upgrading sewage treatment plants, and reducing sewage overflows.

Intervention strategies related to species and population status addressed the protection of key ecological zones, ecosystem-based management (EBM), the development of international treaties, containment

of invasive species, reductions in bycatch, and initiation of local campaigns in coastal communities to improve sustainable fishing, agricultural, and development practices. Solutions particular to the over-exploitation of fisheries (representing 35 out of the 66 articles on species or population status) focused on catch and size limits, individual fishing quotas (IFQs), fishing seasons, permitting, better oversight of commercial fisheries, the reduction of fishing industry subsidies, the creation of undersea reserves, and rights-based management policies.

Articles on offshore drilling were the least likely to include solutions. Some suggestions were directed research on oil-consuming bacteria and establishing marine protected areas (MPAs) in key ecological areas where drilling would be prohibited.

While only a small percentage of the total sample, all articles addressing aquaculture suggested at least one solution. Recommendations ranged from moving open-net fish farms to enclosed, land-based facilities or farther out to sea, building consumer awareness to increase demand for fish from well-regulated aquaculture areas, and reassessing the industry's reliance on small marine species to sustain the growing aquaculture trade.

3.3. Uncertainty

Overall, 49% of all articles contained reference to uncertainty (82 out of 169). The majority of articles on offshore drilling (78%, 18 articles), pollution (60%, 31 articles), aquaculture (60%, 3 articles), and nearly half of all articles on climate change (49%, 39 articles) expressed uncertainty. Fewer instances of uncertainty addressing scientific understanding, assessments, projections, or the plausibility and/or effectiveness of potential solutions were found in articles addressing species or population status (38%, 25 articles)

Articles addressing offshore drilling tended to highlight uncertainty regarding population or ecosystem level impacts, potential long-term impacts, and conflicting scientific claims about oil dispersion. Similarly, articles covering ocean pollution addressed the difficulty of empirically determining the sources and consequences, as well as longer-term impacts of pollution, in several cases expressing skepticism about the methods used or conclusions derived from scientific research (i.e. *"the latest study was limited because it was based on a computer model which is only as good as the input or assumptions on which it is based"* (#107)). The main source of uncertainty identified in articles on aquaculture suggested that the subject is *"not something that's been exhaustively researched"* (#124) and therefore the scientific findings remain inconclusive. Articles on climate change expressed uncertainty regarding scientific assessments and prediction, suggesting that the data is inconsistent, the effects are too small to measure, and that climate science is beleaguered by limitations and missing information. Furthermore, climate change uncertainty focused on the difficulty of predicting complex interactions, as well as specific impacts. Finally uncertainty relative to species and population status highlighted the difficulty of prediction under different potential scenarios, particularly interactions, causal chains, and specific impacts, as well as the accuracy of scientific assessments and projections (i.e. *"these assessments are far from an exact science"* (#59), and *"scientific assessments of the oceans' health are dogged by uncertainty"* (#164)), and uncertainty regarding available information and proposed solutions, for example, *"ecologists know little about the intricate interactions between species in many ecosystems"* (#166) and *"we do not have viable science on how to put Humpty Dumpty back together again"* (#1).

4. Discussion

Paying attention to how we frame any issue matters, and scholars have spent considerable effort attending to the ways that environmental issues have been constructed and shaped through media, as well as potential implications (Corbett and Durfee, 2004; Antilla, 2005; Jones, 2006; Boykoff, 2007; Lakoff, 2010). Framing research has suggested

that although hyperbolic doom and gloom language may initially attract attention to an issue, this type of discourse might induce a sense of pessimistic defeatism that ultimately fails to be an effective tool for motivating people to take action (Ereaut and Segnit, 2006; Foust and Murphy, 2009; O'Neill and Nicholson-Cole et al., 2009). Research on the impact of fear-inducing representations of environmental change on personal engagement has also suggested that doom and gloom framing may give rise to worry, denial, despair, dissonance, paralysis, apathy, and occasionally perverse, reactive behavior (Moser and Dilling, 2004). Furthermore, some scholars have expressed concerns that the apocalyptic framing of environmental issues can not only diminish human agency, but also contribute to skeptics' ability to discredit scientists as unduly alarmist (Leiserowitz, 2007), and serve as fodder for naysayers to portray environmental concerns as overblown or non-existent (Foust and Murphy, 2009). This type of discourse has the potential to divide the public by forcing readers to choose between two distinct and opposing ideological camps, as either believers or non-believers, and thus constructs further barriers to collective action as individuals have not been given more nuanced options for addressing the issue (Foust and Murphy, 2009).

On the other hand, representations that are overly optimistic also have consequences. Optimism bias has been found to function to a great degree across a range of environmental issues, determining that most people, despite where they live, believe that they are safer than those living elsewhere (spatial bias), and better off than future generations (temporal bias) (Gifford et al., 2009; Pahl et al., 2005; Gifford, 2011; Costa-Font et al., 2009). While optimism at the individual level may be good (i.e. Harker and Keltner, 2001), research on dispositional optimism (the general belief that outcomes will be favorable), and optimism bias in particular, suggests that it may not function as well in the realm of complex, societal issues (e.g. Ehrenreich, 2009). For example, optimism bias can lead to different information-seeking and avoidance behaviors (Beattie et al., 2017). Issacowitz (2006) found that those with high dispositional optimism were more likely than their less optimistic peers to practice attentional bias by avoiding negative stimuli, possibly motivated by a desire to regulate their emotions and remain feeling positive. In another example, Ehrenreich (2009) argues that high levels of optimism can lead to the dismissal of disturbing news, failure to notice available warning signs, and undermine preparedness in the face of real threats. Yang and Kahlor (2012) also found that more optimistic people are more likely to avoid or ignore climate change information, and more pessimistic people are more likely to seek out such information. Recent research on optimism bias also indicates that individuals are more likely to integrate new positive information, or information that is better than what they previously believed, than negative information that may paint a gloomier picture (despite the fact that it may be accurate) (Sharot et al., 2011). Optimistic representations may encourage unrealistic confidence in the ability to avoid risks, limit the overall perception of susceptibility, drive information-seeking behaviors geared toward the confirmation of positive information despite real, and perhaps growing, threats, and potentially lead to inertia and a failure to act (Gifford, 2011; Gifford et al., 2009).

Media relaying information on ocean-related environmental issues appears not to be as dominated by doom and gloom rhetoric as some scientists have suggested. While doom and gloom language was present in 10% of all articles (17 out of 169), optimistic language was identified in 27% of all articles (46 out of 169). Furthermore, of the 17 articles that contained doom and gloom language, more than half (10 articles) were found to also contain optimistic language, and this small sub-sample of articles most frequently addressed potential solutions. However, it is worth noting that the headlines were more alarmist than the articles themselves. Some ocean science journalism may be using alarmist rhetoric as a tool to draw attention to an issue in order to highlight solutions and reasons to remain optimistic about outcomes. Overwhelmingly, however, most ocean science journalism reviewed (69%) appears to contain neither hyperbolic doom and gloom language

nor overt ocean optimism. Furthermore, ocean reporting appears to make an attempt of emphasizing solutions. Nearly half of all articles (45%; 76 out of 169 articles) mentioned at least one potential remedial action. The results of this study suggest that the conservation and environmental community, along with science journalists, are in fact not erring too far on any one side by being either unduly alarmist or overtly optimistic in the framing of contemporary ocean health issues, nor are they failing to highlight plausible solutions.

Future research might try to understand how well news reporting on ocean science matches with the research. In a review of whether or not scientists have systematically over or under-predicted various climate-change related projections, Brysse et al. (2013) found that past projections of global mean temperature change, sea level rise, and atmospheric carbon dioxide concentration have in many cases either accurately predicted or underestimated impacts when compared to observed changes (see Rahmstorf, 2007; Pielke, 2008; Allison et al., 2009). The authors concluded that there in fact appears to be a tendency among climatologists to "err on the side of least drama" (Brysse et al., 2013). Furthermore, Risbey's (2008) analysis of several so-called "alarmist" descriptors of climate change (such as "catastrophe," "urgent," "irreversible" and "rapid") and the context in which they were used found their usage "at least arguably reasonable and consistent" with current science (p.35).

Overall, results from this study indicate that U.S. media coverage of marine issues focuses on many of the environmental threats that marine scientists consider most urgent. A broad consensus exists among marine scientists that overfishing, elevated temperatures, contaminated waste, and ocean acidification represent major threats currently impacting marine environments (Boonstra et al., 2015). Our results suggest that in most cases U.S. ocean reporting correspondingly amplifies similar threats through frequency of coverage. Twenty-one percent of all articles addressed overexploitation (a subcategory of ocean species or population status), 23% addressed rising ocean temperatures, and 31% addressed pollution. However, coverage of ocean acidification was less common (7% of the total), and offered little detail beyond mentioning it as an additional stressor on ocean ecosystems. This finding is important, as some scientists have expressed concern that certain threats, such as harmful algal and jellyfish blooms, are overstated in news media and potentially damaging to the credibility of ocean sciences (Duarte et al., 2015). With a total of 6 articles (4% of the total) mentioning harmful algae and only one article (less than one percent of the total) addressing jellyfish blooms, the present study offers little evidence to support this claim, although it may be possible that these articles, while rare, receive disproportionate attention.

Furthermore, U.S. media coverage on ocean impacts that marine scientists have prioritized as most pressing, such as ocean species or population status (in particular, overexploitation) and pollution, was found to predominantly attribute causality to anthropogenic factors. This type of framing undermines the apocalyptic narrative that environmental changes are extra-human, driven by cosmic forces, or otherwise fated (Foust and Murphy, 2009). Attributing causality to human behavior draws attention to the human responsibility to combat detrimental ocean impacts, and places human agency at the heart of the narrative.

While dramatic, sensational, and apocalyptic representations of climate change have been identified as common tropes in mass media (e.g. Doulton and Brown, 2009; O'Neill and Nicholson-Cole et al., 2009), the present empirical look at U.S. media coverage of ocean issues finds such representations to be uncommon. According to this study, the agenda-setting role of news coverage elevates ocean threats that have received the broadest level of scientific consensus with a majority of articles addressing recently published peer-reviewed scientific research and nearly half providing solutions. Furthermore, when present, optimism outnumbers doom and gloom language across all categories.

When examined over time, results show that ocean media coverage drastically increased between 2001–2015, and the percentage of articles that use doom and gloom language, as well as articles that contain both doom and gloom and optimistic language remained small yet fairly stable between 2001 and 2015 (Table S5). However, the percentage of articles that contain only optimistic language appear to be trending downward, replaced by an increase in media coverage that employs a neutral tone (containing neither optimistic nor alarmist rhetoric) (Table S5). Perhaps ocean science journalists are heeding the advice of cognitive psychologists, communication scholars, and concerned marine scientists that an overtly gloomy or optimistic representation of ocean health may have unintended consequences and dampen public support for addressing many of the world's most pressing marine issues.

There is a clear need for the continued rigorous analysis of anthropogenic impacts affecting the oceans. The high levels of uncertainty surrounding scientific understanding, assessments, projections, or the plausibility of potential solutions identified in U.S. ocean media coverage underscore this claim. However, the desire to attain more robust and nuanced evidence must not be taken as an excuse to ignore potential anthropogenic ocean issues, or justify inaction, or an overly optimistic viewpoint. Further research could explore an international perspective by comparing ocean science reporting in mainstream news outlets from various countries, and how different framings of ocean-related issues, particularly those that face uncertainty, can lead to increased public awareness and engagement, as well as support for precautionary and restorative action and policy. This research reveals the inaccuracy of the claim made by some scientists that the U.S. media reporting on ocean issues is disproportionately alarmist.

Acknowledgments

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.gloenvcha.2018.04.002.

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